

Forward/Backward asymmetry of v_n in Cu+Au at RHIC-PHENIX



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Motivation: 3D-initial condition

- ✓ Rapidity dependence of initial condition ?

Signature of **breaking boost invariance** is observed by CMS
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- Forward/Backward flow fluctuation

Possible explanations

- Asymmetric initial geometry : $\varepsilon_n(\eta) \neq \varepsilon_n(-\eta)$
- Twisted $\Phi_n(\eta)$: $\Phi_n(\eta) \neq \Phi_n(-\eta)$

- ✓ Forward/Backward(F/B) asymmetric initial density/geometry in Cu+Au collisions at 200 GeV

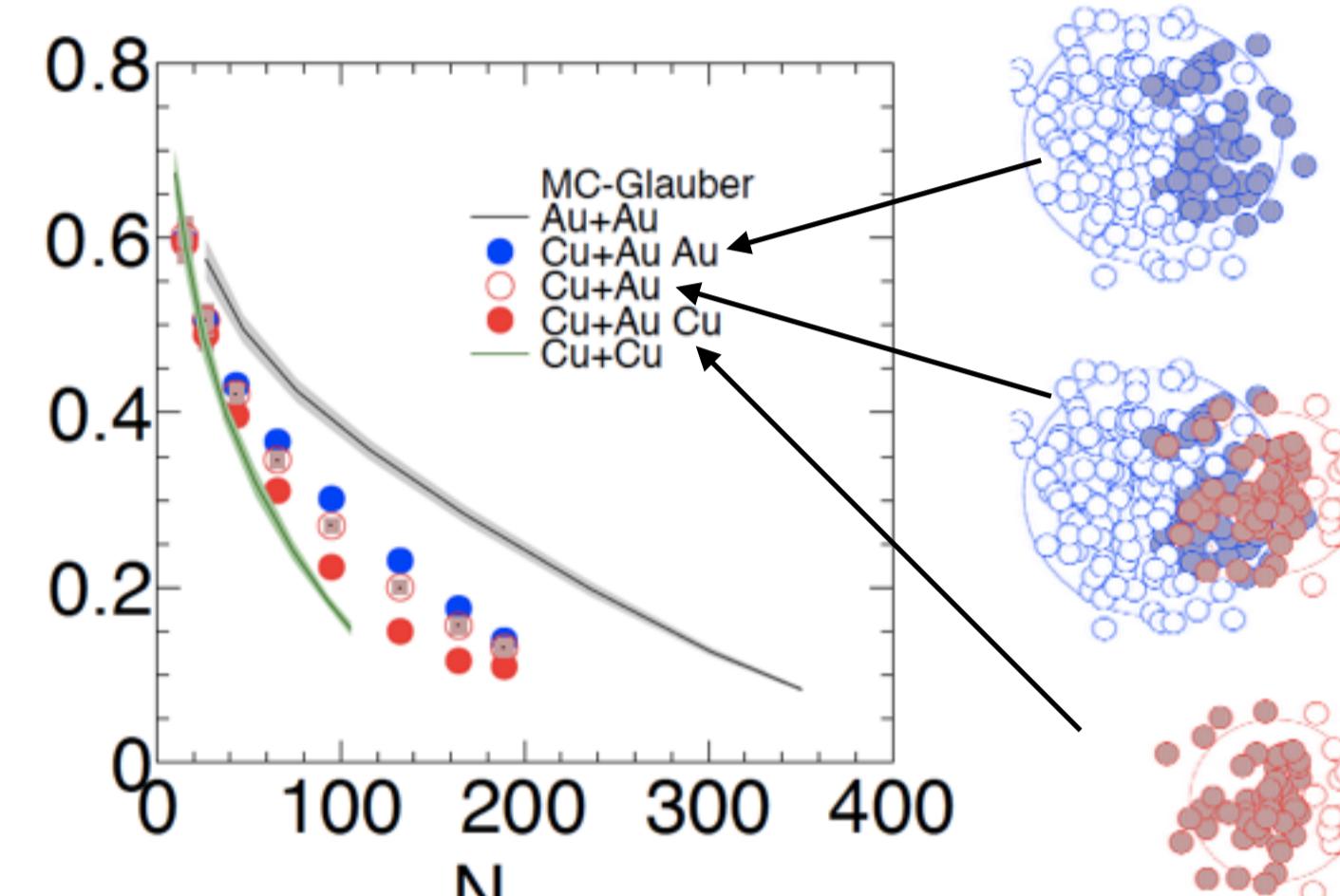
- More participants in Au than those in Cu

- MC-Glauber model shows

$$\varepsilon_{2,Au} > \varepsilon_{2,Cu+Au} > \varepsilon_{2,Cu}$$

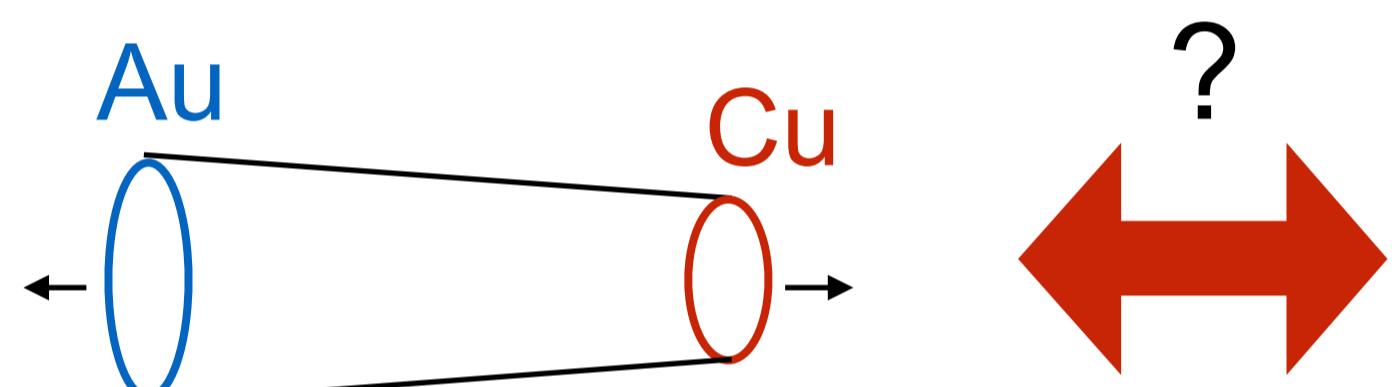
$$\varepsilon_{n,Au(Cu)} = \frac{\langle r^n \cos[n(\phi_{Au(Cu)} - \Phi_{n,Cu+Au})] \rangle}{\langle r^n \rangle} \omega^n$$

$\varepsilon_{2,Au}$, $\varepsilon_{2,Cu+Au}$ and $\varepsilon_{2,Cu}$ are calculated w.r.t same participant plane

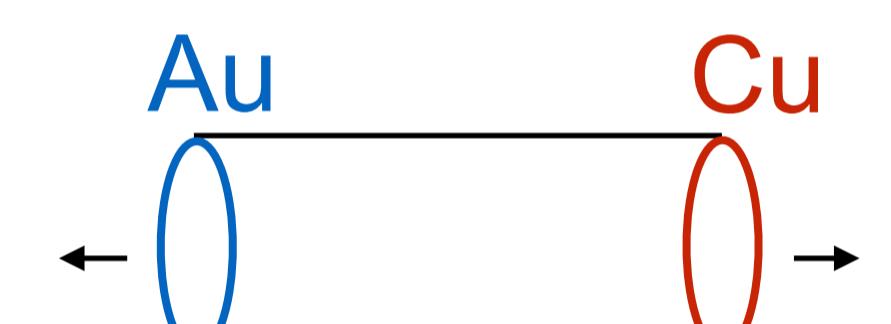


- F/B v_n will provide insight of longitudinal initial geometry

Asymmetric initial geometry

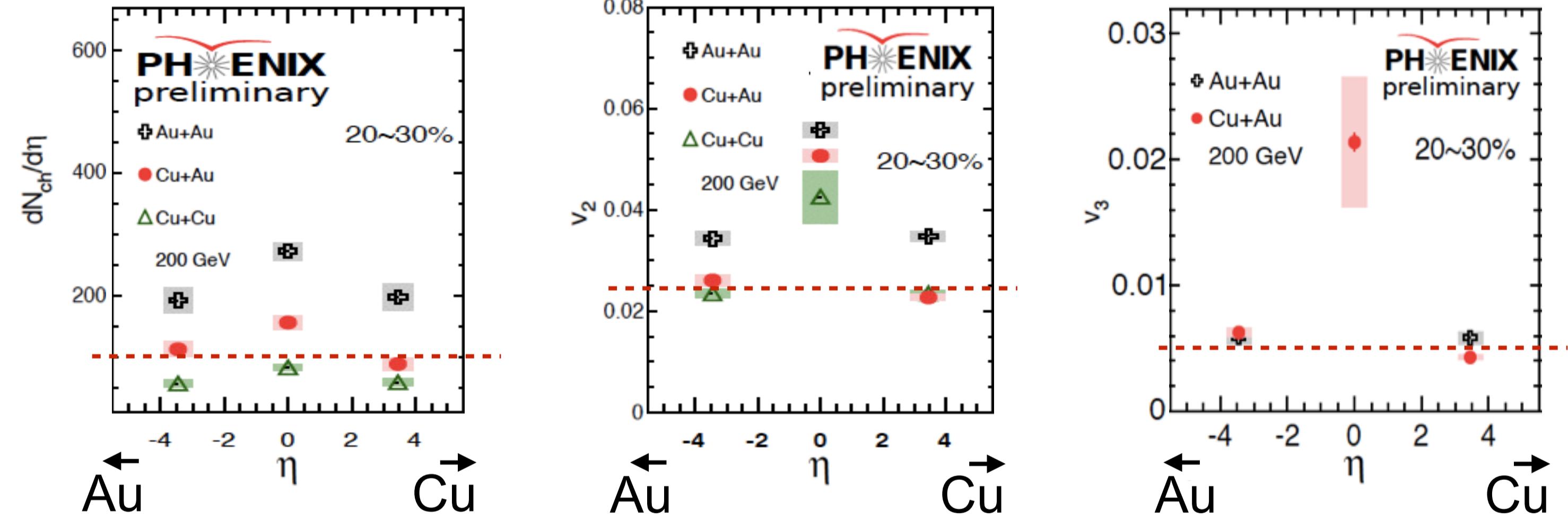


Boost invariance initial geometry



Results: $dN/d\eta$ & v_n

- ✓ η dependence of charged particle $dN_{ch}/d\eta$ & v_n



- Au-going $dN/d\eta >$ Cu-going $dN/d\eta$ in Cu+Au collisions

- $N_{part,Au} > N_{part,Cu}$

→ Larger initial density in Au-going side

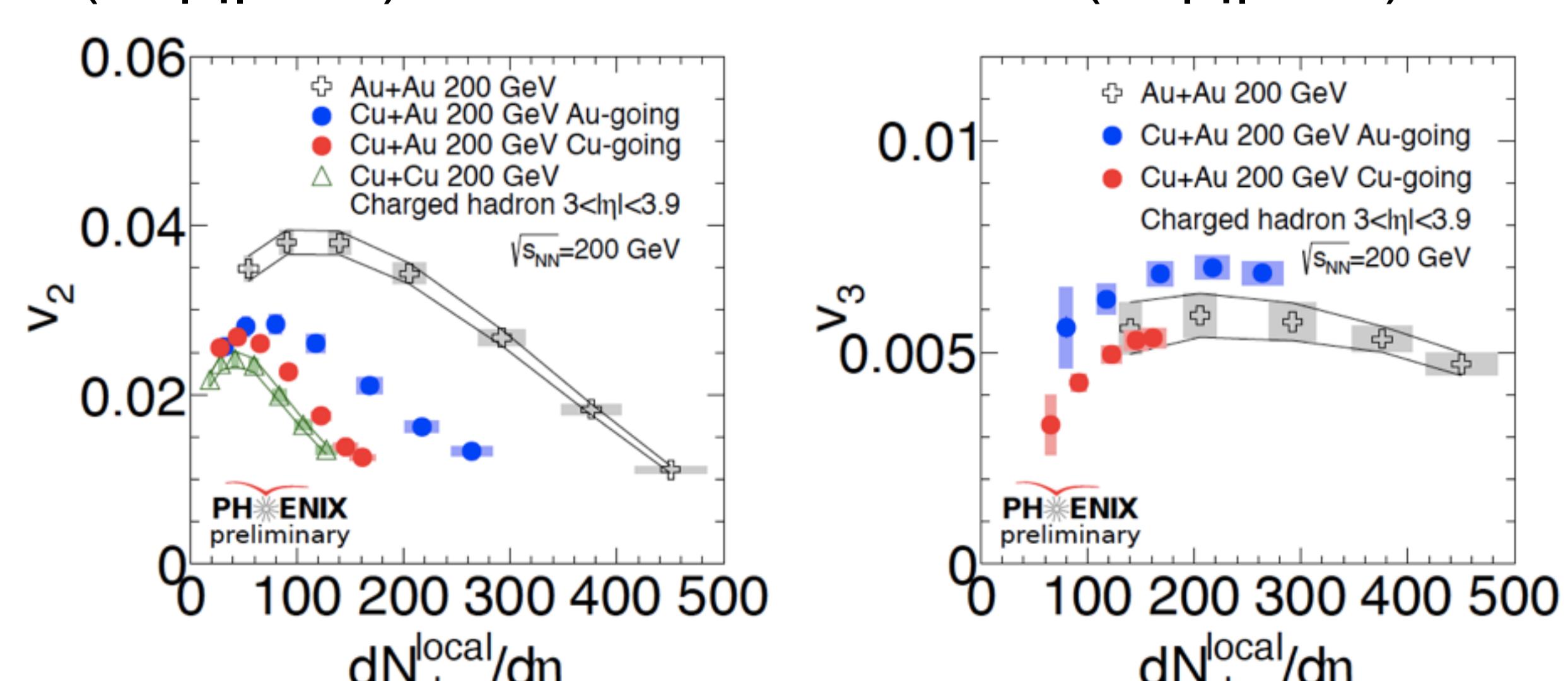
- Au-going $v_n >$ Cu-going v_n in Cu+Au collisions

- Assume rapidity independent event plane, $\Psi_n(\eta) = \Psi_n(-\eta)$

- $\varepsilon_{n,Au} > \varepsilon_{n,Cu}$ & $N_{part,Au} > N_{part,Cu}$

→ Asymmetry of v_n is caused by geometry and/or energy density

- ✓ F/B($3<|\eta|<3.9$) v_n as a function of F/B($3<|\eta|<3.9$) $dN_{ch}/d\eta$



- v_n is plotted as a function of f/b-rapidity $dN/d\eta$
 - At same $dN/d\eta$ bin, the similar initial energy density is expected
 - In Cu+Au collisions, Au-going $dN/d\eta >$ Cu-going $dN/d\eta$
- Au-going side shows larger v_n than Cu-going side
 - Caused by difference of initial geometries between Au and Cu ?

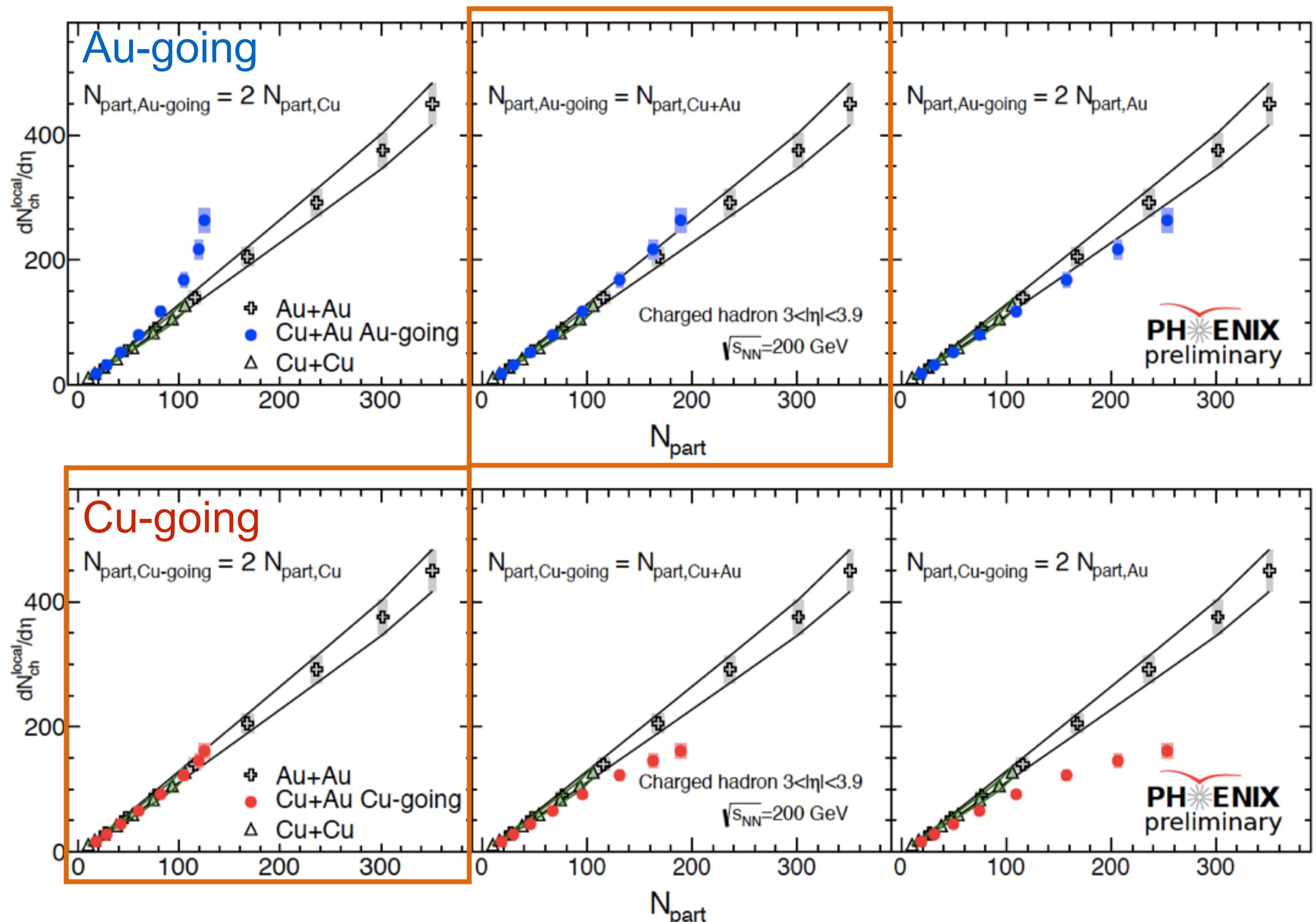
Discussion: initial density

~ N_{part} scaling~

- ✓ F/B $dN_{ch}/d\eta$ is plotted as a function of weighted N_{part}

- Weighted N_{part} ranges $2N_{part,Cu} < N_{part,Cu+Au} < 2N_{part,Au}$
- $N_{part,Au}$ and $N_{part,Cu}$ are participants in Au and Cu, respectively
- Study of relative contribution between Au and Cu nuclei

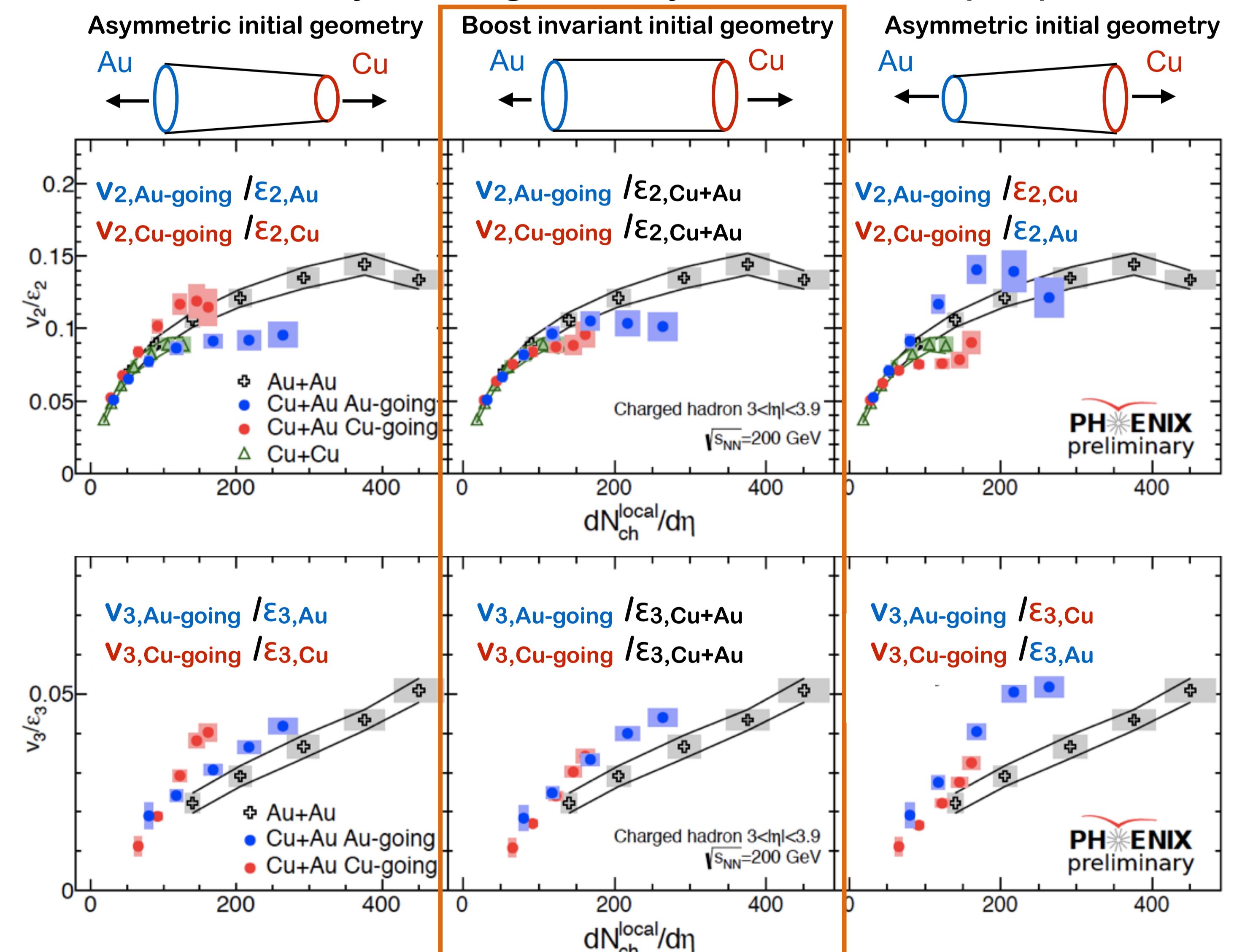
$$2N_{part,Cu} \longleftrightarrow N_{part,Cu+Au} \longleftrightarrow 2N_{part,Au}$$



- Au-going side is determined by both of $N_{part,Au}$ and $N_{part,Cu}$
- Cu-going side is determined pure $N_{part,Cu}$

Discussion: initial geometry ~Eccentricity scaling of v_n ~

- ✓ F/B v_n scaled by initial geometry with/without η dependence



- Failed to scale with rapidity dependence of ε_n
- Deviation is seen between Au-going and Cu-going v_n
- Not consistent among 3 collision systems
- $\varepsilon_{n,Cu+Au}$ is favored
- F/B asymmetry is caused by initial energy density($dN/d\eta$)

Conclusion

- Initial geometry at F/B is common between $-4 < \eta < 4$
- F/B asymmetry of v_n is originally from the intial densities in those regions.